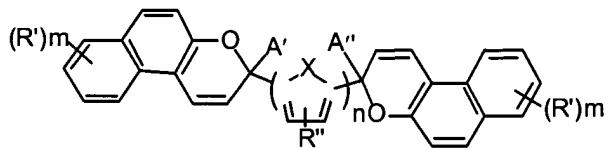


What is claimed is:

5 1. A compound comprising the formula:



wherein X is sulfur or oxygen;

10 R', R'' are the same or different and are each independently hydrogen, hydroxy, halogen, nitro, cyano, allyl, linear or branched (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, (C<sub>1</sub>-C<sub>20</sub>)alkoxy, (C<sub>1</sub>-C<sub>20</sub>)alkylacetylenyl, phenylacetylenyl, (C<sub>1</sub>-C<sub>20</sub>)alkenyl, phenylvinyl, halo(C<sub>1</sub>-C<sub>20</sub>)alkyl, halo(C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, halo(C<sub>1</sub>-C<sub>20</sub>)alkoxy, aryl, aryloxy or heteroaryl optionally substituted with (C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy;

15 arylalkyl or heteroarylalkyl; nitrogen-containing heterocyclic ring having 5 or 6 atoms optionally substituted(C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy, -N(R<sub>1</sub>)R<sub>2</sub>, CON(R<sub>1</sub>)R<sub>2</sub>, wherein R<sub>1</sub> and R<sub>2</sub> may be the same or different and are each independently hydrogen, (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, and optionally substituted phenyl;—OCOR, —COOR or —COR, wherein R represents hydrogen, (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, or aryl or heteroaryl optionally substituted with (C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy;

20 A', A'' may be same or different and are each independently:

25 linear or branched (C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>3</sub>-C<sub>12</sub>)cycloalkyl, aryl(C<sub>1</sub>-C<sub>6</sub>)alkyl or heteroaryl(C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy(C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)alkoxy, halo(C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)haloalkoxy, (C<sub>1</sub>-C<sub>12</sub>)alkylthio; optionally substituted aryl groups; optionally substituted heteroaryl groups;

a group of the following formulae:



5

or

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wherein B is hydrogen, (C<sub>1</sub>-C<sub>12</sub>)alkyl or optionally substituted aryl; unsubstituted or mono-substituted pyrazolyl, pyridyl, imidazolyl, pyrazolinyl, imidazolinyl, or acridinyl, each of the said substituents selected from the group consisting of (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, fluoro, chloro, and phenyl.

(f) a group of the following formulae:



15

or

20

wherein C, D may be the same or different and are each independently carbon, oxygen, (C<sub>1</sub>-C<sub>12</sub>)alkyl nitrogen, or (C<sub>1</sub>-C<sub>12</sub>)acyl nitrogen;

R<sub>3</sub> and R<sub>4</sub> are each hydrogen or (C<sub>1</sub>-C<sub>12</sub>)alkyl; and

wherein the phenyl moiety is optionally substituted with (C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)alkoxy, (C<sub>2</sub>-C<sub>12</sub>)acyl, fluoro, or chloro;

n is an integer from 1 to 8; and

m is an integer from 0 to 3.

25 2. The compound of claim 1, wherein:

X is sulfur or oxygen;

R', R'' are the same or different and are each independently hydrogen, nitro, cyano, allyl, fluoro, chloro, bromo, trifluoromethyl, trichloromethyl, pyrrolidino, piperidino, morpholino, phenyl, benzyl; linear or branched (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, or -OCOR or -COOR wherein R is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl;

A', A'' are the same or different and are each independently:

- linear or branched (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl, aryl(C<sub>1</sub>-C<sub>4</sub>)alkyl or heteroaryl(C<sub>1</sub>-C<sub>4</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy(C<sub>1</sub>-C<sub>6</sub>)alkyl;
- 10 unsubstituted, mono-, di-substituted aryl selected from phenyl or naphthyl,;
- unsubstituted or mono-substituted heteroaryl groups that are furyl, thienyl, pyrrolyl, indolyl, benzofuryl, benzothienyl, pyridyl, dibenzofuryl, dibenzothienyl, or carbazolyl the substituents being
- 15 nitro, amino, cyano, hydroxy, epoxy, hydroxyethoxy, methoxyethoxy, hydroxyethoxyethoxy, methoxyethoxyethoxy, fluoro, chloro, bromo, iodo, vinyl, allyl, trifluoromethyl, phenyl, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, cyclo(C<sub>3</sub>-C<sub>6</sub>)alkyl, cyclo(C<sub>1</sub>-C<sub>6</sub>)alkoxy, (C<sub>1</sub>-C<sub>6</sub>)alkylamino, di(C<sub>1</sub>-C<sub>6</sub>)alkylamino, diarylamino, phenylacetylenyl, or phenylvinyl;
- 20 N(C<sub>1</sub>-C<sub>6</sub>)alkylpiperazino, N-aryl-piperizino, aziridino, indolino, pyrrolidino, pyrrolino, piperidino, (C<sub>1</sub>-C<sub>4</sub>)alkylpiperidino, di(C<sub>1</sub>-C<sub>4</sub>)alkylpiperidino, 4-piperidinopiperidino, morpholino, 2,6-di(C<sub>1</sub>-C<sub>4</sub>)alkylmorpholino, thiomorpholino, thioazolidino, tetrahydroquinolino, or pyrrolyl;
- 25 N(R<sub>1</sub>)R<sub>2</sub>, CON(R<sub>1</sub>)R<sub>2</sub>, wherein R<sub>1</sub> and R<sub>2</sub> are the same or different and are each independently hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl, phenyl or -COR, -OCOR or -COOR wherein R is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl, or phenyl;

30 n is an integer from 1 to 6; and

m is an integer from 0 to 2.

3. The compound of claim 1, wherein:

5 X is sulfur;

R', R'' are the same or different and are each independently hydrogen, nitro, cyano, fluoro, chloro, bromo, pyrrolidino, piperidino, morpholino, phenyl, benzyl, (C<sub>1</sub>-C<sub>4</sub>)alkyl, or (C<sub>1</sub>-C<sub>4</sub>)alkoxy;

A', A'' are the same or different and are each independently:

10 a linear or branched (C<sub>1</sub>-C<sub>4</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl; unsubstituted, mono-, or di-substituted phenyl the substituents being one or more of nitro, amino, acyl, cyano, methoxy, ethoxy, methoxyethoxy, fluoro, chloro, vinyl, allyl, methoxycarbonyl, ethoxycarbonyl, (C<sub>1</sub>-C<sub>4</sub>)alkyl, di(C<sub>1</sub>-C<sub>4</sub>)alkylamino, piperazino, piperidino, arylperidino, morpholino, 15 pyrrolidino, aziridino, acryloxy, methacryloxy, phenylacetylenyl, phenylvinyl; unsubstituted or mono-substituted furyl, thienyl, or pyrryl substituted with a substituent that is (C<sub>1</sub>-C<sub>4</sub>)alkyl or phenyl;

n is an integer from 1 to 4, and

20 m is, independently, integer from 0 to 2.

4. A compound selected from the group consisting of:

5,5'-Bis[3-(p-methoxyphenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'-Bis[3-(p-methylphenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

25 5,5'-Bis[3-(p-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'-Bis[3-(o-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'''-Bis[3-(p-methoxyphenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-[2,2',5',2",5",2"']-quaterthiophene;

5,5'''-Bis[3-(naphthalene-2-yl)-[3H]-naphtho[2,1-b]pyran-3-yl]-[2,2',5',2",5",2"']-

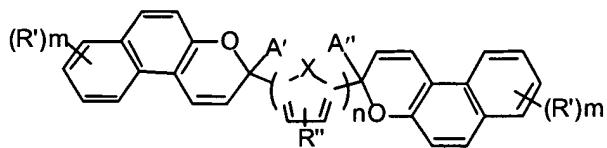
30 quaterthiophene; or

5,5'''-Bis[3-(o-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-[2,2',5',2'',5'',2''']-quaterthiophene.

5 5. The compounds of claim 1, 2, 3, or 4, further comprising a photochromic compound selected from the group consisting of naphthopyran, spirooxazine, one or more nonphotochromic dyes, or a combinations thereof.

6. An ophthalmic lens comprising a compound of the formula:

10



wherein X is sulfur or oxygen;

R', R'' are the same or different and are each independently hydrogen, hydroxy, halogen, nitro, cyano, allyl, linear or branched (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, (C<sub>1</sub>-C<sub>20</sub>)alkoxy, (C<sub>1</sub>-C<sub>20</sub>)alkylacetylenyl, phenylacetylenyl, (C<sub>1</sub>-C<sub>20</sub>)alkenyl, phenylvinyl, halo(C<sub>1</sub>-C<sub>20</sub>)alkyl, halo(C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, halo(C<sub>1</sub>-C<sub>20</sub>)alkoxy, aryl, aryloxy or heteroaryl optionally substituted with (C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy; arylalkyl or heteroarylalkyl; nitrogen-containing heterocyclic ring having 5 or 6 atoms optionally substituted(C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy, -N(R<sub>1</sub>)R<sub>2</sub>, CON(R<sub>1</sub>)R<sub>2</sub>, wherein R<sub>1</sub> and R<sub>2</sub> may be the same or different and are each independently hydrogen, (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, and optionally substituted phenyl; -OCOR, -COOR or -COR, wherein R represents hydrogen, (C<sub>1</sub>-C<sub>20</sub>)alkyl, (C<sub>3</sub>-C<sub>20</sub>)cycloalkyl, or aryl or heteroaryl optionally substituted with (C<sub>1</sub>-C<sub>6</sub>)alkyl or (C<sub>1</sub>-C<sub>6</sub>)alkoxy;

A', A'' may be same or different and are each independently:

linear or branched (C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>3</sub>-C<sub>12</sub>)cycloalkyl, aryl(C<sub>1</sub>-C<sub>6</sub>)alkyl or heteroaryl(C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy(C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)alkoxy, halo(C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)haloalkoxy, (C<sub>1</sub>-C<sub>12</sub>)alkylthio; 5  
optionally substituted aryl groups;  
optionally substituted heteroaryl groups;  
a group of the following formulae:



10 or

wherein B is hydrogen, (C<sub>1</sub>-C<sub>12</sub>)alkyl or optionally substituted aryl; 15  
unsubstituted or mono-substituted pyrazolyl, pyridyl, imidazolyl, pyrazolinyl, imidazolinyl, or acridinyl, each of the said substituents selected from the group consisting of (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, fluoro, chloro, and phenyl.

(f) a group of the following formulae:



20 wherein C, D may be the same or different and are each independently carbon, oxygen, (C<sub>1</sub>-C<sub>12</sub>)alkyl nitrogen, or (C<sub>1</sub>-C<sub>12</sub>)acyl nitrogen;  
R<sub>3</sub> and R<sub>4</sub> are each hydrogen or (C<sub>1</sub>-C<sub>12</sub>)alkyl; and  
25 wherein the phenyl moiety is optionally substituted with (C<sub>1</sub>-C<sub>12</sub>)alkyl, (C<sub>1</sub>-C<sub>12</sub>)alkoxy, (C<sub>2</sub>-C<sub>12</sub>)acyl, fluoro, or chloro;

n is an integer from 1 to 8; and

m is an integer from 0 to 3.

7. The ophthalmic lens of claim 1, wherein:

X is sulfur or oxygen;

5 R', R'' are the same or different and are each independently hydrogen, nitro, cyano, allyl, fluoro, chloro, bromo, trifluoromethyl, trichloromethyl, pyrrolidino, piperidino, morpholino, phenyl, benzyl; linear or branched (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, or -OCOR or -COOR wherein R is hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl;

10 A', A'' are the same or different and are each independently:

linear or branched (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-C<sub>6</sub>)cycloalkyl, aryl(C<sub>1</sub>-C<sub>4</sub>)alkyl or heteroaryl(C<sub>1</sub>-C<sub>4</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy(C<sub>1</sub>-C<sub>6</sub>)alkyl;

unsubstituted, mono-, di-substituted aryl selected from phenyl or naphthyl,;

15 unsubstituted or mono-substituted heteroaryl groups that are furyl, thienyl, pyrryl, indolyl, benzofuryl, benzothienyl, pyridyl, dibenzofuryl, dibenzothienyl, or carbazolyl the substituents being nitro, amino, cyano, hydroxy, epoxy, hydroxyethoxy, methoxyethoxy, hydroxyethoxyethoxy, methoxyethoxyethoxy, fluoro, chloro, bromo, iodo, vinyl, allyl, trifluoromethyl, phenyl, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>1</sub>-C<sub>6</sub>)alkoxy, cyclo(C<sub>3</sub>-C<sub>6</sub>)alkyl, cyclo(C<sub>1</sub>-C<sub>6</sub>)alkoxy, (C<sub>1</sub>-C<sub>6</sub>)alkylamino, di(C<sub>1</sub>-C<sub>6</sub>)alkylamino, diarylamino, phenylacetylenyl, or phenylvinyl;

20 N(C<sub>1</sub>-C<sub>6</sub>)alkylpiperazino, N-aryl-piperizino, aziridino, indolino, pyrrolidino, pyrrolino, piperidino, (C<sub>1</sub>-C<sub>4</sub>)alkylpiperidino, di(C<sub>1</sub>-C<sub>4</sub>)alkylpiperidino, 4-piperidinopiperidino, morpholino, 2,6-di(C<sub>1</sub>-C<sub>4</sub>)alkylmorpholino, thiomorpholino, thioazolidino, tetrahydroquinolino, or pyrryl;

25 N(R<sub>1</sub>)R<sub>2</sub>, CON(R<sub>1</sub>)R<sub>2</sub>, wherein R<sub>1</sub> and R<sub>2</sub> are the same or different and are each independently hydrogen, (C<sub>1</sub>-C<sub>6</sub>)alkyl, (C<sub>3</sub>-

$C_6$ )cycloalkyl, phenyl or  $-COR$ ,  $-OCOR$  or  $-COOR$  wherein R is hydrogen,  $(C_1-C_6)$ alkyl,  $(C_3-C_6)$ cycloalkyl, or phenyl;

n is an integer from 1 to 6; and

m is an integer from 0 to 2.

5

8. The ophthalmic lens of claim 1, wherein:

X is sulfur;

$R'$ ,  $R''$  are the same or different and are each independently hydrogen, nitro, cyano, fluoro, chloro, bromo, pyrrolidino, piperidino, morpholino, phenyl, benzyl,

10  $(C_1-C_4)$ alkyl, or  $(C_1-C_4)$ alkoxy;

$A'$ ,  $A''$  are the same or different and are each independently:

a linear or branched  $(C_1-C_4)$ alkyl,  $(C_3-C_6)$ cycloalkyl;

unsubstituted, mono-, or di-substituted phenyl the substituents being one or more of nitro, amino, acyl, cyano, methoxy, ethoxy, methoxyethoxy, fluoro, chloro, vinyl, allyl, methoxycarbonyl, ethoxycarbonyl,  $(C_1-C_4)$ alkyl, di( $C_1-C_4$ )alkylamino, piperazino, piperidino, arylperidino, morpholino, pyrrolidino, aziridino, acryloxy, methacryloxy, phenylacetylenyl, phenylvinyl;

15 unsubstituted or mono-substituted furyl, thienyl, or pyrryl substituted with a substituent that is  $(C_1-C_4)$ alkyl or phenyl;

20 n is an integer from 1 to 4, and

m is, independently, integer from 0 to 2.

9. An ophthalmic lens comprising a compound selected from the group 25 consisting of:

5,5'-Bis[3-(p-methoxyphenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'-Bis[3-(p-methylphenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'-Bis[3-(p-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

5,5'-Bis[3-(o-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-2,2'-bithiophene;

30

5,5'''-Bis[3-(p-methoxyphenyl)-[3H]-  
[2,2',5',2",5",2'']]-quaterthiophene;  
5,5'''-Bis[3-(naphthalene-2-yl)-[3H]-naphtho[2,1-b]pyran-3-yl]-[2,2',5',2",5",2'']-  
quaterthiophene; or  
5 5'''-Bis[3-(o-fluorophenyl)-[3H]-naphtho[2,1-b]pyran-3-yl]-[2,2',5',2",5",2'']-  
quaterthiophene.

10. The ophthalmic lens of claim 6, 7, 8, or 9, further comprising a photochromic compound selected from the group consisting of naphthopyran, spirooxazine, one or 10 more nonphotochromic dyes, or a combinations thereof.

11. A method for making a naphthopyran compound comprising the step of coupling a propargyl alcohol with a naphthol in the presence of a catalytic amount of an acid, a solvent and 3Å molecular sieves to generate the naphthopyran compound.